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(54) **ROTARY PUMP, SYSTEM COMPRISING THE PUMP AND OPERATING METHOD OF THE PUMP**

(57) A rotary pump applicable to an internal combustion engine, comprising a pump body (20), a rotor (11) arranged to rotate inside the body, at least one vane (12) applied to the rotor (11) and arranged to suck a fluid from at least one suction port (14) and to let out the fluid through at least one outlet device (41). The pump comprises a heating device located near the outlet device (41) and arranged to heat, in use, the outlet device (41) for limited time periods. The invention also concerns a system comprising the pump and a method of controlling the system comprising the pump.

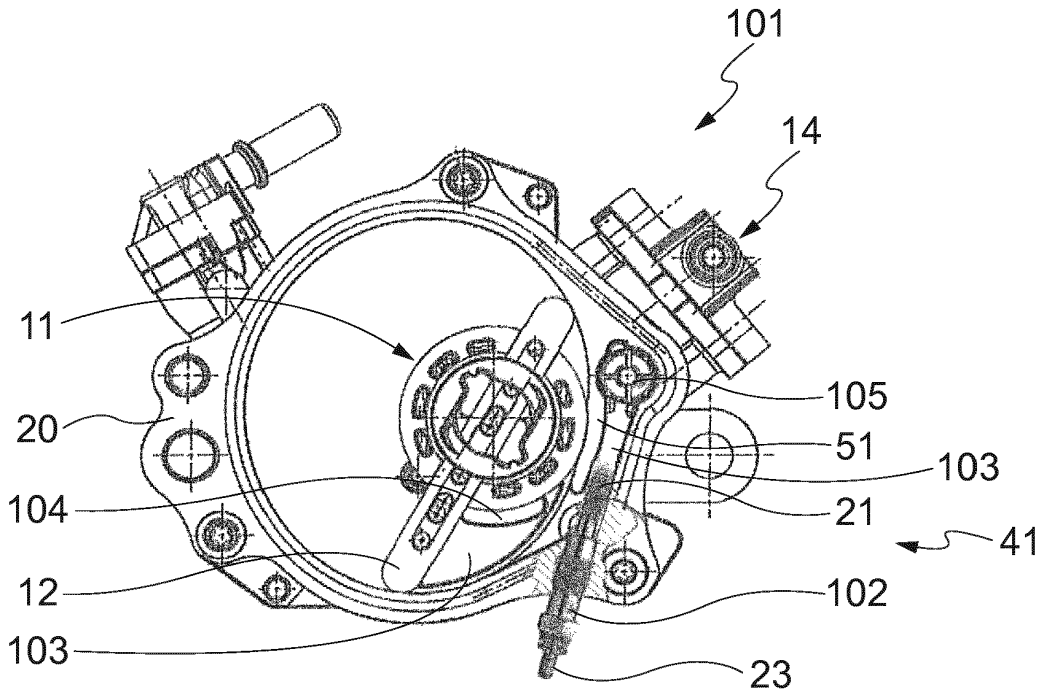

Fig. 1

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Description

Technical field

[0001] The present invention generally relates to a rotary pump for fluids

[0002] More particularly, the present invention relates to a single-vane vacuum pump, to which reference will preferably be made hereinbelow.

Prior Art

[0003] Rotary pumps, for instance single-vane or multiple-vane vacuum pumps applied in internal combustion engines for operating servo-brakes or other services in a vehicle, are well known.

[0004] Such pumps generally consist of a structure including a one-way exhaust valve, which is so dimensioned as to ensure discharge of the pumped fluid.

[0005] A known problem of such pumps is that, in certain critical situations, such as at low temperatures of pump operation and/or start, the discharge valve generally is not sufficient for discharging the very dense fluid present in the pump in the above conditions, with a consequent hydraulic lock of the pump, a strong increase in the pump resistant torque and possible seizure or breaking of the pump and/or the pump vane.

[0006] According to a first kind of prior art solution for such a problem, the discharge valve as well the pump structure are dimensioned by taking into account the critical situations instead of the normal operating conditions of the pump.

[0007] However, such a solution entails that a number of pump components and the structure of the pump itself are over-dimensioned so as to bear the increase in the pump resistant torque at low operation temperatures, e. g. -40°C, and/or at the start.

[0008] A second kind of prior art solution is disclosed for instance in patent application published under No. WO 2010025799 A2, where a bypass channel is provided that can be opened by means of a control device so as to discharge the fluid present in the pump towards the discharge valve.

[0009] Also in this kind of solution however it is to be expected that at least the pump discharge valve is to be over-dimensioned so as to bear the increase in the resistant torque in the critical situations.

[0010] Generally speaking, the Applicant has noticed that the prior art generally fails to effectively solve the problem of the increase in the resistant torque in the critical situations without over-dimensioning in some manner the pump discharge valve, the pump components and/or the structure of the pump itself.

Description of the invention

[0011] It is an object of the present invention to solve the problems mentioned above of the prior art.

[0012] This object is achieved through a rotary pump having the features set forth in the appended claims.

[0013] The present invention also concerns a system comprising the pump and an operating method of the system comprising the pump according to the invention.

[0014] The claims are integral part of the technical teaching provided herein in respect of the invention.

[0015] The following synthetic description of the invention is given in order to provide a basic understanding of some aspects of the invention.

[0016] This synthetic description is not a thorough description and, as such, it is not to be intended as being suitable for identifying key or critical elements of the invention, or suitable for defining the object of the invention. It only aims at setting forth some concepts of the invention in simplified form, as an anticipation of the detailed description that follows.

[0017] In accordance with a feature of a preferred embodiment of the present invention, the rotary pump internally has a heating element arranged to heat, in use, very dense fluid present in the pump.

[0018] In accordance with another feature of the present invention, the heating element is located in the vicinity of devices arranged to make the fluid present in the pump discharge.

[0019] In accordance with a further feature of the present invention, the pump is applied to an internal combustion engine and the heating element is included in a heating device arranged to be controlled by a control unit depending on ambient temperature values and/or engine temperature values.

Brief Description of the Figures

[0020] The above and other features and advantages of the present invention will become apparent from the following description of a preferred embodiment made by way of a nonlimiting example with reference to the accompanying drawings, in which elements denoted by a same or similar numerical reference denote elements having the same or similar function and construction, and in which:

- Fig. 1 shows the rotary pump according to the invention;
- Fig. 2 shows the rotary pump of Fig. 1 with the lid mounted thereon; and
- Fig. 3 shows an exemplary block diagram of a system comprising the pump shown in Fig. 1.

Description of a Referred Embodiment

[0021] Referring to Fig. 1, there is shown a rotary pump 101, for instance a single-vane vacuum pump, made in accordance with the present invention.

[0022] Pump 101 includes a body 20 internally having a rotor 11 where a vane 12 slides, which vane is arranged to suck a fluid from at least one inlet or suction port 14,

to compress the fluid and/or to discharge it, in known manner, through pump outlet devices 41 arranged to safely discharge the fluid.

[0023] In the preferred embodiment, outlet devices 41 include an outlet passage 104 controlled by a non-return valve, known per se, and a drain 51, controlled by a valve 105 for protection against counter-rotation, known per se.

[0024] More preferably, outlet passage 104 and drain 51 are formed in a discharge chamber 103, provided in a predetermined position in outlet devices 41 of pump 101.

[0025] In accordance with the preferred embodiment, pump 101 includes at least one heating device 102, e.g. a glow plug 102, at least partly inserted into pump body 20. The heating device has at least one heating element 21 at a first end and a terminal 23 at a second end, which terminal, in use, is electrically connected to a control unit 111, arranged to activate or deactivate the heating of plug heating element 21 for short periods.

[0026] Heating device 102 is for instance a glow plug of the kind used in Diesel engines in order to start the engine.

[0027] Preferably, heating element 21 of the glow plug is inserted into pump body 20 and consequently in the vicinity of discharge chamber 103 of pump 101.

[0028] More preferably, heating element 21 of glow plug 102 is located in the vicinity of discharge chamber 103 or, in any case, in the vicinity of outlet passage 104 and drain 51.

[0029] In the preferred embodiment, the pump is installed for instance in an internal combustion engine and has discharge chamber 103 or, in any case, outlet passage 104, drain 51 and glow plug heating element 21 in its lower portion.

[0030] The term "lower portion" is used to indicate that, preferably, heating of the pump insider is performed in a region or "lower portion" where it is more likely that fluid, for instance oil, accumulates, for instance due to gravity force, when the pump is not operating.

[0031] The pump, in use, is a structure closed by a lid 106 (Fig. 2) that, preferably, leaves terminal 23 for the electrical connection of glow plug 102 to control unit 111 accessible.

[0032] Hereinafter an exemplary block diagram of a system 10 comprising pump 101 according to the invention applied to an engine 112, for instance an internal combustion engine, is provided.

[0033] In the preferred embodiment, system 10 includes a control device 109, of a known type, arranged for instance at least to control the switching on or off of the engine, and temperature sensors 108, also of known type, arranged to detect, for instance, both the temperature of engine 112 in which pump 101 is mounted, and the ambient temperature.

[0034] Preferably, control device 109 has an own internal clock 110 and has, for instance, its input connected to temperature sensors 108 and its output connected to control unit 111.

[0035] System 10 as described is arranged to enable turning on heating element 21 of glow plug 102 based on temperature readings carried out by control device 109 by means of the temperature sensors and on consequent commands for switching on glow plug 102, transmitted through control unit 111.

[0036] Some examples of operation strategies for system 10 described above is described below.

[0037] According to a first strategy, for instance, temperature sensors 108 transmit information concerning the external temperature to control device 109, and clock 110 transmits information concerning inactivity time periods of engine 112 to the control device.

[0038] If the external temperature is lower than a predetermined value, for instance 3 to 5°C, and the engine inactivity time period has exceeded a predetermined period, for instance 2 hours, with low residual engine temperature, for instance lower than 10°C, then, when the engine is turned on, control device 109 is set to command activation of the heating of heating element 21 of glow plug 102 for a predetermined activation time period, for instance a few seconds.

[0039] According to another strategy, when the engine is turned on, control device 109 is set to command activation of the heating of glow plug 102 for a predetermined time period depending only on the ambient temperature and/or the engine temperature.

[0040] According to yet other strategies, turning on of control unit 111, and hence activation of the heating of glow plug 102, can be carried out, for a given reading and check of the ambient and engine temperatures, for instance upon recognition of a signal indicating the opening of a vehicle door or of the engine ignition command by control device 109.

[0041] In case of recognition of the engine ignition command by control device 109, it is preferable that activation of the heating of glow plug 102 is carried out in continuous or pulsed manner with a time advance, for instance by some seconds, with respect to the actual engine ignition, depending on the pump installation characteristics.

[0042] In case of Diesel engines, such a time advance may for instance coincide, or be in phase, with the preheating of the ignition glow plugs.

[0043] In case of petrol engines, such a time advance may be a predetermined time period, for instance a short time advance by some seconds, or a time period determined as a function of temperature ranges detected by the ambient temperature sensor and/or the engine temperature sensor.

[0044] The system as described is preferably applicable to single-vane vacuum pumps in which engine oil residues are present in the pump after the engine has been turned off.

[0045] Of course, however, the system is also applicable to multiple-vane vacuum pumps as well as to oil pumps.

[0046] Thanks to the provision of a heating device, such as for instance a glow plug, the system according

to the invention is capable of ensuring that oil residues present in the pump after the engine has been turned off are made so fluid as under the normal operating conditions of the engine.

[0047] Thanks to such a technical effect, it is possible to dimension the pump components and the pump structure in optimum way, without taking into account overpressures due to long engine stops at low temperatures.

[0048] For instance, the Applicant has noticed that the pressures that can occur in prior art pumps when the engine is turned on can be even 10 times higher than the pressures existing under normal operating conditions of the engine, whereby the pump components and the pump structure have to be dimensioned accordingly.

[0049] Thanks to the present invention, it is to be expected that the size of the pump components and of the pump can be reduced by one order of magnitude with respect to the prior art pump components and pump structures

[0050] Of course, obvious changes and modifications to the above description in respect of size, shapes, materials, components and connections, as well as in respect of the illustrated construction and the operating manner are possible without departing from the scope of the invention as set forth in the following claims.

Claims

1. A rotary vacuum pump applicable to an internal combustion engine and comprising:

- a pump body (20),
- a rotor (11) arranged to rotate inside said body,
- at least one vane (12) applied to said rotor (11) and arranged to suck a fluid from at least one suction port (14) and to let out the fluid through at least one outlet device (41),

characterised by:

- a heating device (102) connected to a control unit (111) arranged to switch on and off said heating device, said heating device being at least partly inserted into the pump body (20), near said at least one outlet device (41) of said pump (101), and being arranged to heat, in use, for a limited time, said at least one outlet device (41) under the control of said control unit.

2. The pump according to claim 1, wherein said at least one outlet device (41) comprises a fluid outlet passage (104).

3. The pump according to any one of previous claims, wherein said heating device is a glow plug (102) having at a first end at least one heating component (21) inserted into the pump body (20) near a discharge chamber (103) of said outlet device (41) of said pump (101), and at a second end a terminal (23) electrically connectable to the control unit (111).

4. The pump according to any one of previous claims, wherein said pump is a single-vane vacuum pump.

5. A system arranged to manage a pump applied to an internal combustion engine, comprising:

- at least one temperature sensor (108) arranged to sense temperatures;
- at least one control device (109) arranged to read the temperatures sensed by said at least one temperature sensor (108),

characterised in that:

- said pump is a pump as claimed in any one of the previous claims,

and **in that**

- said control device (109) is arranged to power on and/or off the control unit of the heating device of said pump on the basis of the temperatures read by said control device (109).

6. The system according to claim 5, wherein said at least one temperature sensor comprises:

- an ambient temperature sensor, and/or
- an internal combustion engine temperature sensor.

7. A method for controlling a system arranged to manage a pump applied to an internal combustion engine, wherein said system comprises:

- at least one control device (109) arranged to read temperatures sensed by at least one temperature sensor (108) arranged to sense ambient temperatures or engine temperatures,
- a rotary pump (101) having a a pump body (20) and comprising at least one outlet device (41) arranged to let out fluid,
- a heating device (102) located inside the pump body near said outlet device (41),

said method comprising the steps of:

- reading said temperatures sensed by said at least one sensor (108);
- switching on said heating device (102) by means of said control device (109) on the basis of the temperatures sensed by said at least one temperature sensor.

8. The method according to claim 7, wherein said step of switching on said heating device comprises the further step of:

- reading the engine temperature and/or the ambient temperature by means of the control de-

vice (109).

9. The method according to any one of claims 7 to 8, wherein said step of switching on said heating device is performed by said control device (109) a limited number of seconds in advance of the engine start.

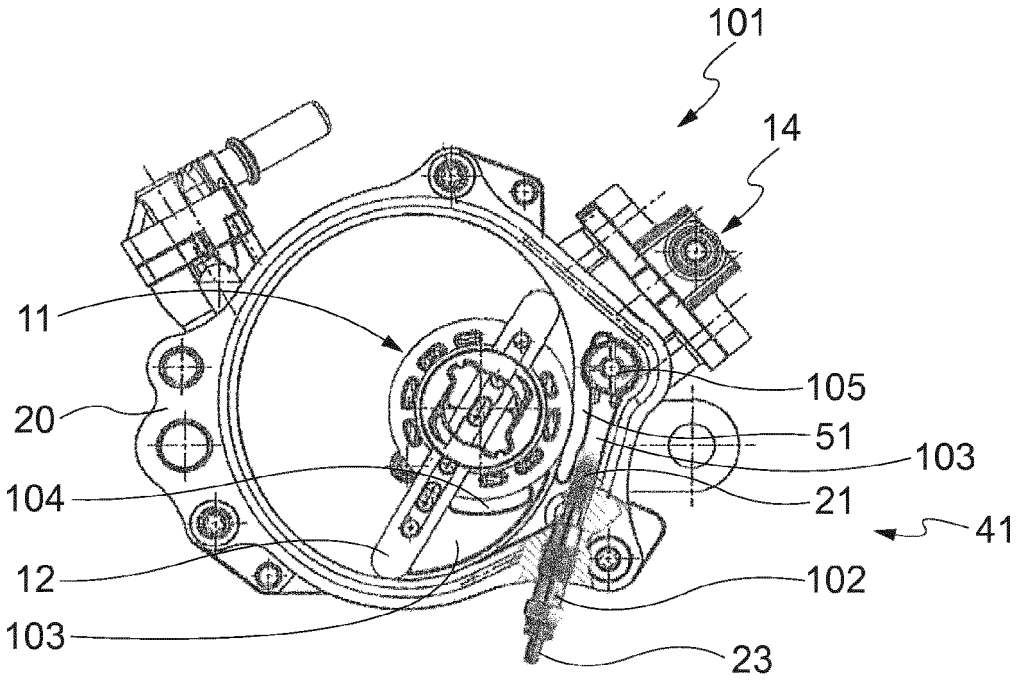

Fig. 1

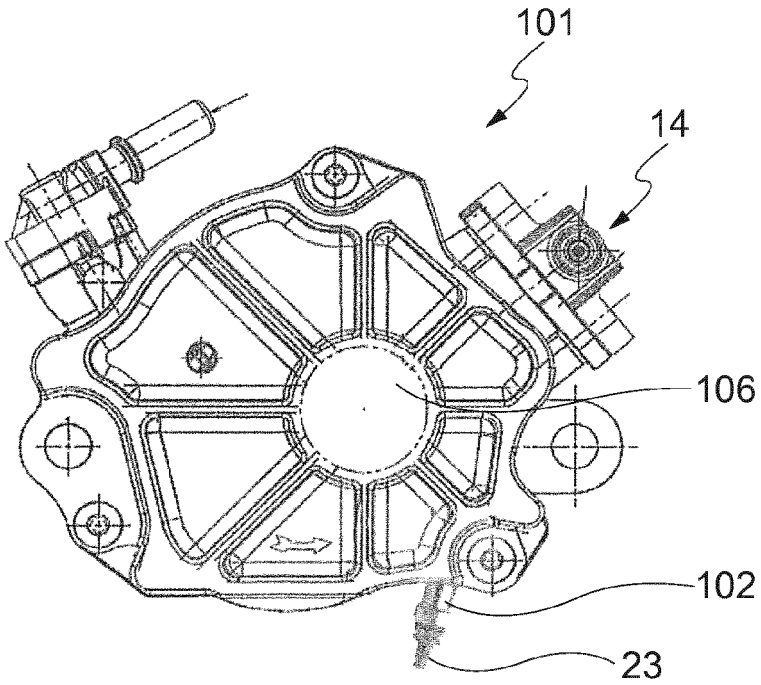

Fig. 2

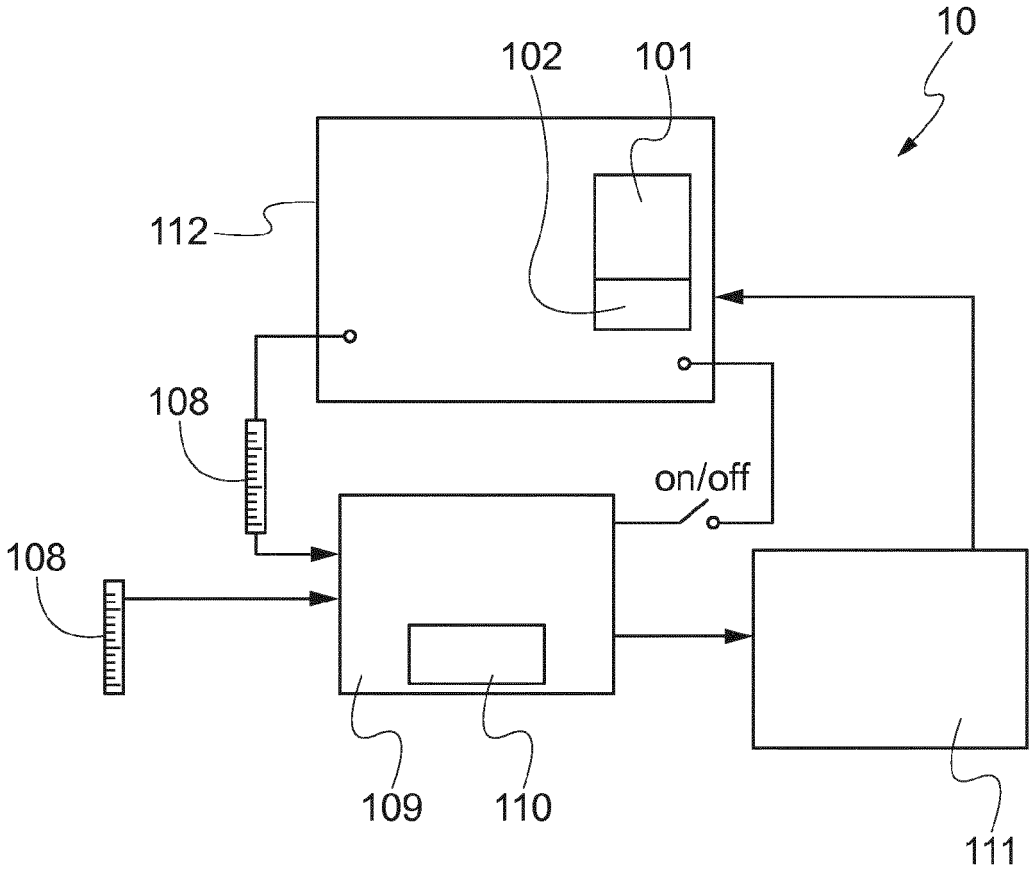

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 15 18 5278

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	DE 22 16 930 A1 (BRAND FA RUDOLF) 18 October 1973 (1973-10-18) * page 2 - page 4 * * figures *	1-9	INV. F04C29/04 F04C18/344 ADD. F04C25/02
A	GB 2 430 474 A (DANA AUTOMOTIVE LTD [GB]) 28 March 2007 (2007-03-28) * page 1, line 6 - page 6, line 26 * * figure *	1-9	
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A	US 2011/008194 A1 (MAYER JAMES [US] ET AL) 13 January 2011 (2011-01-13) * paragraph [0012] * * paragraph [0024] - paragraph [0034] * * figures 1,3-5 *	1-9	TECHNICAL FIELDS SEARCHED (IPC)
A	US 2013/201316 A1 (BINDER YEHUDA [IL] ET AL) 8 August 2013 (2013-08-08) * paragraphs [0052], [0056], [0059], [0092], [0096] * * paragraphs [0108], [0116], [0163], [0200], [0297] * * paragraph [0426] - paragraph [0428] * * paragraph [0469] - paragraph [0476] * * paragraph [0628] - paragraph [0631] * * figures 5,6,7,17,25,26 *	1-9	F04C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	26 November 2015	Bocage, Stéphane

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 15 18 5278

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26-11-2015

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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